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ORIGINAL ARTICLE

RADIOLOGICAL OUTCOME OF SCAPHOID NONUNION TREATED WITH TRICORTICAL ILIAC CREST AUTOGRAFT

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ABSTRACT

Background: Fractures of the scaphoid are one of the most common significant wrist injuries. Most of these fractures, if diagnosed early and treated promptly, heal well. This study aimed to determine the radiological outcome of scaphoid nonunion treated with tricortical iliac crest autograft.

Materials & Methods: A total of 30 patients were included in the study. Patients who had trauma three or more months back and had a visible fracture and a humpback were included in the study. In contrast, patients who were previously operated on for scaphoid pathologies or had preexisting arthritis were excluded. Plain radiographs in AP (including scaphoid), Lateral view, CT and MRI, were ordered, and baseline investigations were done in all patients.

Results: Out of the included 30 patients, 26 (86%) were male, and the remaining 04 (14%) were female. The mean age of our patients was 32.5±5.87 years. Right-sided scaphoid nonunion was present in 21 (70%) patients and left in 09 (30%) patients. The dominant hand was involved in 23 (76.66%) patients, while 07 (23.34%) had involvement of their nondominant hand. The majority (73.3%, n=22) of patients had nonunion scaphoid due to failed conservative treatment, while 08 (26.6%) patients had nonunion due to delay in diagnosis. Postoperatively all patients achieved radiological union. The mean union time was 12±3 weeks. All patients followed up to 24±3 weeks.

Conclusion: Scaphoid nonunion can be treated with a bone graft from iliac crest graft along with fixation with Herbert headless compression screw with an excellent radiological outcome.

KEY WORDS: Scaphoid Bone; Iliac Crest Bone; Autograft; Bone Screws.

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INTRODUCTION

Scaphoid fractures are one of the most common upper limb injuries accounting for approximately 70 percent of wrist bone fractures. The majority of fractures heal when treated early and properly.[1-5] According to epidemiological research, the occurrence of these injuries varies between 0.08 and 1.21 per 1000 person-years in various populations. Conservative techniques are often used to treat such fractures, with union rates ranging from 55 to 100 percent in most cases.[1] Around 10 percent of scaphoid fractures result in nonunion.[2] Fractures of the proximal pole and displaced fractures generally progress to nonunion.[2] To prevent nonunion, Davis recommended that fractures with more than 3 mm displacement be treated operatively at early presentation.[2]

A plain x-ray, CT or MRI can be used to diagnose and determine the displacement of scaphoid fractures. For diagnosing the scaphoid fracture displacement, the sensitivity of plain X-rays is very low, i.e., up to 33 percent.[3] Hence, a timely CT scan or MRI should be carried out in scaphoid fractures. Failure or late diagnosis of these injuries often leads to scaphoid nonunion. More complex injuries in their advanced stages progress to scaphoid nonunion advanced collapse.[4] It results in pain, early osteoarthritis, and decreased wrist movements. The changes in the arthritic range from arthritis of the radial styloid to pan-carpal arthritis.[5]

Changes in scaphoid fracture treatment aim to reduce wrist pain, attain solid consolidation, avoid the growth

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of wrist arthritis, and attain the excellent position of scaphoid.[6] Scaphoid fractures in case of surgical treatment, comprises of fixation and reduction of scaphoid fractures, with or maybe in lack of bone graft. A bone graft may be vascularized and non-vascularized.[7] Scaphoid nonunion can be treated using a number of different bone grafting techniques. The differences between these procedures include the harvesting location of the bone graft, the manner of stabilization, and the use of nonvascularized or vascularized bone grafts.[8]

Nonvascularized bone grafts may be taken from various sites, but the distal radius and the iliac crest are most frequently used.[9] Fisk at first projected a wedge-shaped corticocancellous bone graft, whereas Fernandez, later on, tailored this method by utilizing a graft from the iliac crest, internal fixation, and a volar approach.[10,11] The Fisk-Fernandez method provide a union rate greater than 90 percent and reliable deformity correction.[12,13] It is most commonly utilized to treat unstable scaphoid nonunion. We have deployed the Fernandez technique.

The objective of this study was to determine the radiological outcome of scaphoid nonunion treated with tricortical iliac crest autograft. We postulated that tricortical iliac crest autograft restores the scaphoid length and corrects flexion deformity in scaphoid nonunion.

MATERIALS AND METHODS

This study was conducted in the Orthopedic and Trauma Department, Khyber Teaching Hospital Peshawar, from January 2022 to December 2023. Our descriptive study included patients of both genders with scaphoid nonunion who presented it to our orthopedic outdoor department (OPD). Nonunion of the scaphoid was defined as a non- healing fracture of greater than 12 weeks duration with no signs of bridging calluses on x-rays and CT. Patients having a visible fracture site on x-ray and humpback deformity and had a history of trauma 03 months back were recruited for the study. In contrast, patients presenting with avascular necrosis, past surgical history of scaphoid or wrist procedures, or symptoms and signs of osteoarthritis were excluded. The Ethical Review Committee of KTH approved this study and patients were consented for surgery with tricortical iliac crest graft. A thorough history and physical examination were completed preoperatively. Plain radiographs in two planes anteroposterior (AP), Lateral and scaphoid view, CT, and MRI were taken, and baseline investigations were completed preoperatively as per hospital guidelines.

Surgical Technique

All patients with scaphoid nonunion were treated with tricortical iliac crest autograft. All patients were given prophylactic pre-operative antibiotics (Injection cefoperazone + sulbactam 2 gram) as per institutional guidelines.

before the induction of GA and tourniquet inflation. The same team operated on all patients. The Volar (modified Henry) approach was used with a 4 to 6-cm incision over the flexor carpi radialis tendon. (Fig A to E) The approach was made between flexor carpi radialis tendon and radial artery. The joint capsule was longitudinally incised, and Radio-Scapho-Capitate and Radio-Lunate ligaments were retracted or divided to visualize scaphoid nonunion. The fracture site was exposed and was curetted until a paprika sign appeared.

A tricortical graft was harvested from the iliac crest on the same side, using an osteotomes, introduced into the fracture nonunion and fixed with headless titanium Herbert screw by identifying the anterior surface of the trapezium for screw placement. A screw was slightly shorter than the measured guidewire and was inserted over it using an image intensifier. The maintenance of height and fracture reduction was confirmed under image intensifier. Closure was done in layers including the repair of the joint capsule and palmar ligaments. Tourniquet was released, hemostasis was secured, and a scaphoid cast was applied for six weeks. After six weeks the cast was removed, and a removable thumb abduction splint was applied for the next six weeks. A post-op radiograph was taken, and the patient followed at two weeks for stitches removal and wound assessment, and the scaphoid cast was reapplied and then followed at six weeks, three months, and then every 4th week up to 24 weeks. OPD radiographs were taken at each subsequent follow up and assessed by an independent orthopedic surgeon for the disappearance of fracture line and bone healing. Patients underwent supervised physiotherapy, with the protocol consisting of active exercises of the ipsilateral upper limb joints while the cast was on, followed by active forearm and wrist range of motion exercises after removing the cast. Once functional range of motion was achieved, all patients were started on strengthening exercises and advised to bear as tolerated, including heavy manual work.

The data was collected on an excel spreadsheet and analyzed with SPSS v25. Quantitative data including age, preoperative time and time to surgery had mean and standard deviation calculated while percentages were calculated for qualitative variables.

RESULTS

We operated on 30 patients of scaphoid nonunion with tricortical iliac crest autograft. Of 30 patients, 26 (86%) were male, and 04 (14%) female. The study population mean age was 32.5±5.87 years. Nonunion on the right side was present in 21 (70%) patients while the remaining 09 (30%) patients had left side nonunion. 23 (76.66%) patients had dominant hand involvement, while 07 (23.34%) patients had nondominant hands. The majority (73.3%, n=22) of patients had nonunion due to failure of nonoperative management, while 08 (26.6%) patients had nonunion

due to delay in diagnosis. Postoperatively radiological union was achieved in the whole study population, with 12±3 weeks being the mean time to union.. All patients followed up to 24±3 weeks. It took an average of 18±3 weeks for patients to return to their functional level. No patient was lost to follow-up. No nonunion, malunion, degenerative arthritis, infection, and donor site morbidity was noted in our series.

During the study, no infections or postoperative complications necessitated a second procedure.

Table 1. Clinical outcome based on demographics

Variables	N (%)
Gender	
Male	26 (86%)
Female	04 (14%)
Hand Side Involved	
Right	21 (70%)
Left	09 (30%)
Hand Dominance	
Dominant hand involvement	23 (76%)
Nondominant hand involvement	07 (34%)
Cause of Nonunion	
Failed conservative treatment	22 (73.3%)
Delayed diagnosis	08 (26.6%)
Union achieved	30 (100%)
Mean union time	12 ± 3 weeks
Mean follow-up time	24 ± 3 weeks

Pre, per op and follow up shown

DISCUSSION

Managing the nonunion of the scaphoid is as complicated as long bone nonunion because the scaphoid blood supply is compromised and delayed recognition and diagnosis of scaphoid fracture.

The Herbert compression screw provides tight internal fixation and mobilizes the wrist early. For the reduction of the fracture segment, Herbert screws are used. With this technique, high union rates, lower morbidity and quicker functional recovery have been reported.[14] A durable tricortical graft from the iliac crest is required to restore scaphoid length. Numerous studies have shown a high union rate when using a vascularized distal radius graft. However, this surgery is technically challenging and may be difficult to perform for the common orthopedic practitioner.

Ramamurthy et al.[15] reported a 71% union rate using iliac crest and distal radius graft in 126 cases of nonunion of scaphoid. While in our study, a 100% union rate was reported using iliac crest graft. Han et al.[16] study showed involving 30 patients with scaphoid waist nonunion demonstrated a 100 percent union rate with nonvascularized iliac crest grafting. The results of which are parallel to our study.

Tambe et al.[18] reported a 66 percent union rate in 44 cases using iliac crest grafting. While in our study, the union rate for nonvascularized iliac crest graft was much higher than in the abovementioned study. A 100 percent union rate was reported by Finsen et al.[19] in 14 cases utilizing iliac crest grafts. In contrast, a 72 percent union rate was observed in 25 cases involving distal radius grafts, according to the same authors. While in our study, a union rate of 100 percent was reported in 30 cases utilizing iliac crest grafts. Bushnelletal et al.[20] reported a complication rate of 29%, with nonunion being the most common. While in our study, no postoperative complications were reported.

Each study has limitations, and this study was no exception. The sample size was limited, and the follow-up time was short. Our findings may be biased since no comparison group with non-vascular or vascular distal radius bone graft was used. However, the study's strength is that we used the tricortical iliac crest as a graft source in all cases. Another drawback of this study was that we employed a single institution's (one center's) database, which, while generated by many surgical teams, limits the generalizability of our findings. We suggest a multicenter study with a larger sample size and a more extended follow-up period for all future studies. Similarly, we recommend a randomized control trial study design for future studies to minimize the degree of bias and increase the generalizability of the findings.

CONCLUSION

Scaphoid nonunion can be reliably treated successfully with a wedge-shaped iliac crest graft and fixation with headless Herbert screws with excellent radiological outcomes. The high learning curve associated with vascularized grafts should be reserved for patients with persistent avascular necrosis and those undergoing revision surgery.

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CONFLICT OF INTEREST
Authors declare no conflict of interest.
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AUTHORS' CONTRIBUTION

The following authors have made substantial contributions to the manuscript as under:

Conception or Design:	QA, AJM
Acquisition, Analysis or Interpretation of Data:	QA, AJM, NR, MSF
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All the authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.